SOIL ORGANIC MATTER: THE PASTURE'S TEMPERATURE GAUGE

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On cold winter mornings, a close eye is kept on the old truck's temperature gauge. Everyone appreciates it when the cab warms up, and getting the fluids up to temperature also helps the engine smooth out and run at peak efficiency. There is an analogous gauge for a pasture's status: the soil organic matter (OM) level. Increasing the OM in your pastures' soil can even out its performance and ensure that it is functioning at peak efficiency.

Scientifically speaking, soil OM is a collective term that refers to the amount of carbon-based material in the soil. In a practical sense, however, soil OM quantifies the living component of the soil (i.e., roots, fungi, bacteria, earthworms, etc.).

Soils in a pasture are a site of much activity, albeit hard to see. Here, an earthworm navigates the root mass of annual ryegrass and arrowleaf clover plants under the remnants of a manure paddy.

Lately, there has been a renewed interest in the effects of management on soil OM levels in pastures, including lots of weblog commentary and discussions in various media outlets. Much of this interest is in the context of on-going drought stress, challenges to pasture productivity in response to climate change, and a resurgence of interest in alternative grazing methods. However, good graziers have known the benefits of increased soil OM for some time. Soils that are high in soil OM act as a sponge to hold more water, reduce soil density (compaction), have a higher cation exchange capacity, are more resistant to soil acidification by N fertilizers, have more stable soil temperatures, host more beneficial microorganisms, and provide a reservoir for the rhizobia that infect legume nodules and biologically fix N.

Scientists have also documented the benefits of pastoral land uses on soil OM. Research has shown that pastures in the Southeast, for example, had greater than 50% more soil OM on average than neighboring croplands. When croplands are converted into pastureland, the soil OM shows an almost immediate marked increase, usually by 0.1 to 0.2 percentage points per year in the first few years. It has also been shown that this rate of soil OM accumulation is sustained for the first 10 - 20 years following conversion. In soils converted from cropland to pasture in the Southeast, soil OM is estimated to increase to approximately 50% of its theoretical maximum within 10 years of conversion and up to ~80% of this maximum by year 25.

My colleagues and I at the University of Georgia have documented some of the highest rates of soil OM increase on record. We observed that soil OM levels increased by approximately 0.35 percentage points for each of the first 3 years when cotton and peanut cropland was converted to a dairy practicing management-intensive grazing (Table 1). The increase from around 1% OM to over 2% in 3 years time was nearly unbelievable. Subsequently, we have confirmed this rate of change and have recently been examining which part of the forage system contributes the most to this change. We've also been evaluating how much of the OM buildup is due to the roots, plant litter, and animal manure by monitoring the radioisotope signatures of these sources of biomass as they decompose and become incorporated into the soil.

Table 1. Improvement in soil OM over three years (2007-2009) in three paddocks on a pasture-based dairy near Wrens, GA after conversion from cotton/peanut cropland.

Paddock	Initial	Year 1	Year 2	Year 3
	------ Soil Organic Matter, % ------			
Paddock 4	1.08	1.15	1.25	2.20
Paddock 8	1.01	1.17	1.59	2.18
Paddock 14	1.14	1.63	1.86	2.00
Avg.	1.07	1.32	1.57	2.13

Our preliminary results seem to indicate that the roots and root exudates are the major sources of soil OM improvements. These results support the findings of a consortium of American and European scientists in a recent review in the journal *Nature*. Their controversial report challenged the long-held belief that crop residues and biomass on the soil surface are the source of soil OM buildup.

The evidence is mounting for the conclusion that roots and root exudates are responsible for the majority of biologically-active soil OM. Whether large or small, the roots and the fungal mycelia that grow in association with them will thoroughly explore every nook and cranny of the soil, even the microscopic pores and crevices in the soil particle. Added to the root and fungal mass, there are root exudates (e.g., suberin) that lubricate and protect the roots as they slip through the soil and the sugars and protein that the roots exude to feed their fungal dance partners. Though these forms of carbon were once assumed labile and easily decomposed, current research is showing them to be incredibly resilient and stable, often residing in the soil for 30 to 50 years after their creation.

So, what does all this mean, and what does it matter? It shows that improvements in grazing management that focus on encouraging root development rather than accumulating plant litter is the mechanism that will provide the greatest improvements in soil OM. This means a focus on rotational grazing techniques is critical.

The root systems of pasture plants in continuously stocked pastures are short and shallow (Figure 1). These plants are commonly grazed every 2 to 7 days, on average. Rotationally stocked pastures allow pasture plants a recovery period that is long enough to promote a more robust root system to develop.

Soils in a pasture system have a distinct soil OM and soil health advantage over continuously cropped soils, but tremendous improvements over common, continuous grazing methods can still be had. Implementing advanced grazing management can make the pasture more resilient to drought and climatic stresses, as well as provide all the many other benefits of a rationally grazed system.

Figure 1. Bahiagrass plants subjected to simulated grazing by clipping to a 2 inch residual every 2, 7, or 21 days for a period of 3 months. Shoot growth represents 1 week's regrowth.